

What is claimed:

1. A data synchronization method for a redundant data storage arrangement in which there are at least a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, writes to the first and second remote storage entities being tracked via respective first and second sidefiles, the first and second storage entities having different levels of write-currency relative to each other, the method comprising:

comparing the first sidefile with the second sidefile; and

updating writes stored at the second remote storage entity based upon the comparison of the first and second sidefiles.

2. The method of claim 1, wherein the updating of writes includes forwarding to the second remote storage entity writes that are present in the first sidefile but not yet present in the second sidefile.

3. The method of claim 1, wherein the comparing is done on the basis of sequence numbers associated with the writes.

4 The method of claim 1, further comprising:

establishing a communication connection between the first and second remote storage entities in response to the primary storage entity becoming inoperative;

wherein the comparing and updating are also performed in response to the primary storage entity becoming inoperative.

5. The data synchronization arrangement of claim 1, further comprising:

configuring the first and second sidefiles to store a fixed number of writes therein, respectively; and

adding a new write to the first and second sidefiles by overwriting the oldest write therein, respectively.

6. The data synchronization arrangement of claim 1, further comprising:  
adaptively adjusting the number of writes that can be stored in the first sidefile.
7. The data synchronization arrangement of claim 6, wherein the adaptive adjustment is based upon the writes are stored in the second sidefile.
8. The data synchronization arrangement of claim 7, wherein the adaptive adjustment more particularly is based upon the write stored in the second sidefile which has the oldest contiguous sequence number.
9. The data synchronization arrangement of claim 7, further comprising:  
identifying at least some of the writes stored in the second sidefile; and  
then  
accordingly informing the first remote storage entity regarding such identities.
10. The data synchronization arrangement of claim 1, further comprising:  
configuring the first sidefile to include a field that is used to track whether a write has been acknowledged by the second remote storage entity as having been received.
11. The data synchronization arrangement of claim 1, further comprising:  
providing a third sidefile via which writes received thereby are tracked;  
and  
configuring the third sidefile to include a field that is used to track whether a write has been acknowledged by the second remote storage entity as having been received.
12. The data synchronization arrangement of claim 11, further comprising:

configuring the third sidefile further to include a field that is used to track whether a write-acknowledgement forwarded from the second remote storage entity has been acknowledged as having been received by the first remote storage entity.

13. A redundant data storage arrangement comprising:

a primary storage entity to forward writes to each of a mirroring first and second remote storage entity;

the mirroring first remote storage entity, in communication with the primary storage entity, which includes a first sidefile via which writes forwarded from the primary storage entity are tracked; and

the mirroring second remote storage entity, in communication with the primary storage entity, which includes a second sidefile via which writes forwarded from the primary storage are tracked;

the first and second storage entities having different levels of write-currency relative to each other;

an initiating one of the first and second remote storage entities being operable

to compare the first and second sidefiles, and

invoke an updating of writes stored at the second remote storage entity based upon the comparison of the first and second sidefiles.

14. The data synchronization arrangement of claim 13, wherein the updating is performed by the first remote storage entity, which is operable to do so by forwarding to the second remote storage entity writes that are present in the first sidefile but not yet present in the second sidefile.

15. The data synchronization arrangement of claim 13, wherein each of the first and second remote storage entities is operable to

preserve in the respective sidefile sequence numbers associated with the writes; and

sort the respective sidefile according to the sequence numbers.

16. The data synchronization arrangement of claim 13, wherein:  
the initiating one is further operable to establish a communication connection between itself and the other remote storage entity in response to the primary storage entity becoming inoperative; and  
the comparison and the update are performed in response to the primary storage entity becoming inoperative.
17. The data synchronization arrangement of claim 13, wherein the first remote storage entity is closer in proximity to the primary storage entity than the second remote storage entity.
18. The data synchronization arrangement of claim 13, wherein:  
the first and second sidefiles are configured to store a fixed number of writes therein, respectively; and  
the first and second remote storage entities are operable to add a new write to the first and second sidefiles by overwriting the oldest write therein, respectively.
19. The data synchronization arrangement of claim 13, wherein:  
the first remote storage entity is operable to adaptively adjust the number of writes that can be stored in the first sidefile.
20. The data synchronization arrangement of claim 19, wherein the adaptive adjustment is based upon the writes are stored in the second sidefile.
21. The data synchronization arrangement of claim 20, wherein the adaptive adjustment more particularly is based upon the write stored in the second sidefile which has the newest contiguous sequence number.
22. The data synchronization arrangement of claim 20, wherein:

the primary storage entity is operable to identify at least some of the writes stored in the second sidefile and then accordingly inform the first remote storage entity regarding such identities.

23. The data synchronization arrangement of claim 13, wherein:

the first sidefile includes a field that is used to track whether a write has been acknowledged by the second remote storage entity as having been received.

24. The data synchronization arrangement of claim 13, wherein:

the primary storage entity includes a third sidefile to track writes received thereby;

the first sidefile including a field that is used to track whether a write has been acknowledged by the second remote storage entity as having been received.

25. The data synchronization arrangement of claim 24, wherein the first sidefile further includes a field that is used to track whether a write-acknowledgement forwarded from the second remote storage entity has been acknowledged as having been received by the first remote storage entity.

26. The data synchronization arrangement of claim 13, wherein each of the first and second remote storage entities represents a tracked write in the first and second sidefile, respectively, with: location information as to where on a physical medium the write is to be performed; actual data associated with the write that is to be written to the physical medium; and a sequence number uniquely associated with the write.

27. The data synchronization arrangement of claim 13, wherein:

the first remote storage entity receives writes forwarded synchronously from the primary storage entity; and

the second remote storage entity receives writes forwarded asynchronously from the primary storage entity.

28. A data synchronization method for a redundant data storage arrangement in which there are at least a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, the method comprising:

synchronously receiving writes at the first remote storage entity that have been forwarded from the primary storage entity; and

maintaining a sidefile via which are tracked items that include

writes received at the first remote storage entity, and

writes received at the second remote storage entity.

29. A mirroring first remote storage entity for a redundant data storage arrangement in which there are at least the first remote storage entity and a primary storage entity in communication therewith, and a mirroring second remote storage entity in communication with the primary storage entity, respectively, the first remote storage entity comprising:

memory to store data; and

a processor operable to

synchronously receive writes that have been forwarded from the primary storage entity; and

maintain a sidefile in the memory via which are tracked items that include

writes received at the first remote storage entity, and

writes received at the second remote storage entity.

30. A data synchronization method for a redundant data storage arrangement in which there a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, the method comprising:

synchronously forwarding to the first remote storage entity writes from the primary storage entity; and

informing the first remote storage entity regarding writes acknowledged to have been received at the second remote storage entity.

31. A primary storage entity for a redundant data storage arrangement in which there are at least the primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, the primary storage entity comprising:

memory to store data; and

a processor operable to

synchronously forward writes to the first remote storage entity;

receive indications of writes acknowledged to have been received at the second remote storage entity; and

inform the first remote storage entity regarding the indications.

32. A redundant data storage arrangement comprising:

primary storage means for storing writes received from a host;

first remote mirror means for mirroring writes forwarded from the primary storage means and for tracking such writes via a first sidefile; and

second remote mirror means for mirroring writes forwarded from the primary storage means and for tracking writes such writes via a second sidefile;

the first and second storage entities having different levels of write-currency relative to each other;

comparison means, responsive to the primary storage means being rendered inoperative, for comparing the first and second sidefiles, and

update means, responsive to the comparison, for updating writes stored at the second remote mirror means based upon the comparison of the first and second sidefiles.

33. A computer-readable medium having code segments embodied thereon execution of which cause a machine to synchronize data for a redundant data storage arrangement according to the method of claim 1.

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